Effect of fertilizer on bromegrass forage yield and quality

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Introduction

Grasses such as bromegrass require relatively large amounts of N and, within a year to two following establishment, have generally exhausted the supply of available soil N. Mineralization processes in the soil cannot supply available N at a rate to provide for unrestricted growth of the crop. In west-central and northwestern Saskatchewan, high yields and sustained production of bromegrass are not possible without input of nitrogen fertilizer. Deficiencies of phosphate, particularly in older stands, also may restrict yields. On bromegrass stands which have reached the declining yield stage, strong responses to high rates of N are usually obtained if moisture is available for yield expansion. It is generally poor economy to grow bromegrass for hay or pasture without the use of fertilizers.

Materials and Methods

Sources of N and P were granular ammonium nitrate (33.5-0-0) and treblesuperphosphate (0-45-0) respectively. Fertilizers were applied in the fall (September) or spring (April) by broadcasting on the surface of the soil. On the Whitewood loam and Loon River loam, the bromegrass stands were 3 to 4 years old at the time of fertilizer application, and on Scott loam, the stand was approximately 14 years old. Forage yields were obtained by cutting the crop approximately 2 inches above ground level, recording green weights, then oven-drying the forage to determine percent dry matter and converting the yields to a dry weight basis. Protein contents were determined by the Kjeldahl method on samples dried at 75° C. *In vitro* digestible organic matter (IVDOM) content was determined using sheep rumen fluid by the method used by the Saskatchewan Feed Testing Laboratory and is reported on a dry matter basis.

Results and Discussion

The effects of fertilizers on yield and protein contents of bromegrass forage obtained in 1973 on Loon River loam (grey-wooded) and Scott loam (dark brown) are presented in Tables 1 and 2. Responses to current application (direct) and to residual N are shown. The differences in total yields and responses to N rates at the two locations are partly due to differences in growing season precipitation. Rainfall during May to July at Loon Lake (Loon River loam) was almost double that at Scott. Residual response on the Loon River loam was for the year following fertilizer application, and on Scott loam for the second year after application, showing the rapid decline in residual effect at the lower rates of N. In order to assess properly the value of a fertilizer application on grassland, it is necessary to measure residual effects over a period of several years. Data given in Tables 3 and 4 show the contributions of direct and residual fertilizer nitrogen to bromegrass forage yields on Whitewood loam and Scott loam and indicate that even the highest rates of N used can be economical if responses are measured

over a period of 3 years. Results of studies carried out on Whitewood loam (Table 5) show that periodic application of high rates of N can give larger total production of forage over a period of several years than smaller annual applications. However, there is a danger of excessive NO_3-N accumulation in the forage when high rates of N are applied, particularly if the forage is to be utilized in early stages of growth as for pasture (Tables 6 and 7). Rates of N up to 200 lb/acre can be safely applied for hay production.

A study was carried out in 1971 on an old bromegrass stand on Scott loam to determine the effects of N rates and cutting dates on yield and quality of bromegrass forage. Results are shown in Figures 1 to 4. The effect of fertilizer treatments on dry matter yields measured at different dates during the growing season is shown in Figure 1. Yields of forage and response to N generally vary from season to season. Maximum yields of dry matter occurred on about July 28 in 1971. Yields increased quite steeply as the rate of N increased up to 320 lb/acre, as shown in Figure 2. Relationship between D.M. yields, protein content and protein yield are shown in Figure 3. Maximum yields of protein generally occur earlier in the season than maximum D.M. because of the rapid decline in protein content as the season progresses. The leaf:stem ratio decreases rapidly as bromegrass age advances during the season due to the rapid increase in stem material and a decline in leaf yield, as shown in Figure 4. Leaves made up approximately 46, 28 and 18 percent of total dry matter for the 160 lb N treatment on June 25, July 8 and July 19 dates, respectively. Nitrogen fertilizer stimulated production of stem, leaf and head (inflorescence) components.

Stem material was substantially lower in protein content than the leaves and heads and declined more rapidly as the season progressed, and as a result, even though yield of leaf material was much lower than that of stems, total protein production was highest in leaves at the hay stage (July 8), as shown in Table 8. In vitro digestible organic matter content (IVDOM) was closely related to protein content and both increased with increasing rate of applied N (Table 9). As would be expected, both protein and IVDOM were markedly higher early in the season than at the hay stage.

Table 1. Effect of N fertilizer on yields and protein content of bromegrass on Loon River loam - 1973.

lb/ac N	D.M. Yield lb/ac Direct	% Protein	D.M. Yield lb/ac Residual	% Protein
20	3084	6.77	2377	7.92
40	3843	7.12	2349	8.89
80	4964	7.52	3080	8.86
160	5541	9.14	3584	7.50
Check	1998	8.00	1795	8.68

Table 2. Effect of N and P fertilizers on yield and protein content of bromegrass on Scott loam - 1973.

lb/ac N	lb/ac P_2O_5	D.M. Yield lb/ac Direct	% Protein	D.M. Yield lb/ac Residual	% Protein
40	0	1219	10.38	545	8.39
80	0	1663	11.84	491	7.79
160	0	1401	14.83	542	8.86
240	0	1667	15.84	1045	9.67
320	0	1920	18.44	1078	10.50
480	0	2060	17.47	1390	11.23
0	80	1111	7.68	651	7.06
40	80	1952	9.32	594	7.58
80	80	2695	8.53	651	7.75
160	80	3227	13.14	775	8.65
240	80	3828	13.15	861	7.55
320	80	3744	15.39	1466	8.48
480	80	3977	15.83	2242	10.97
Check		535	9.23	535	9.23

Table 3. Direct and residual effects of nitrogen fertilizers on forage yields of bromegrass - Whitewood loam.

lb/ac* N	D.M. (lb/ac) First Year (Direct)	2 Additional Years (Residual)	Total	Increase
20	1916	1403	3319	673
40	2649	1498	4171	1525
80	4020	2242	6262	3616
160	5675	3246	8921	6275
Check	1499	1147	2646	

* Ammonium nitrate 33.5-0-0 applied in the fall.

Table 4. Direct and residual effects of nitrogen fertilizers on forage yields of bromegrass - Scott loam.

lb/ac* N	lb/ac* P_2O_5	D.M. (lb/ac) First Year Direct (1 cut)	2 Additional Years Residual (3 cuts)	Total	Increase
40	80	2258	1642	3900	1944
80	80	4053	1960	6013	4057
160	80	3436	2538	5974	4018
240	80	3883	3602	7485	5529
320	80	4452	4790	9242	7286
480	80	3535	5605	9140	7184
Check		1014	1541	1956	

* Fertilizers applied in the spring.

Table 5. Effects of annual and large single applications of N on yields of bromegrass hay - Whitewood loam.

lb/ac N	D.M. (lb/ac) 3-year Total*	Increase
80 (annually X 3)	7919	5881
160 (annually X 3)	8216	6178
240 (first year only)	10947	7762
500 (first year only)	15452	12267

* Single cuts each year only where N was applied annually in the spring Total of 5 cuts in 3 years where N was applied in the spring of the first year only.

Table 6. Effect of N fertilizer on NO_3-N in bromegrass forage - Loon River loam.

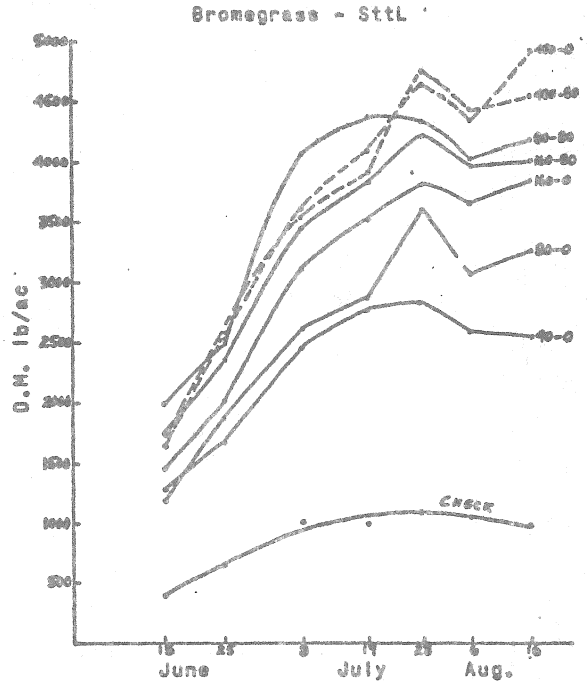
lb/ac* N	% NO_3-N in forage June 11	July 8
80	0.02	0.03
240	0.42	0.19
320	0.44	0.35
500	0.87	0.52
Check	0	0

* 33.5-0-0 broadcast in April.

Table 7. Effect of N fertilizers on NO_3-N in bromegrass forage - Scott loam.

lb/ac*		% NO_3-N in forage			
N	P_2O_5	June 15	June 25	July 8	July 19
80	80	0.058	0.059	0.048	0.007
160	80	0.124	0.100	0.062	0.014
240	80	0.265	0.157	0.080	0.028
480	80	0.299	0.256	0.130	0.058
Check		0.046	0.048	0.076	0.040

* Fertilizers broadcast in April.



Date of cut, 1971

Figure 1. Yields of bromegrass forage cut on different dates as influenced by fertilizer treatments (N-P_2O_5) - Scott loam, 1971.

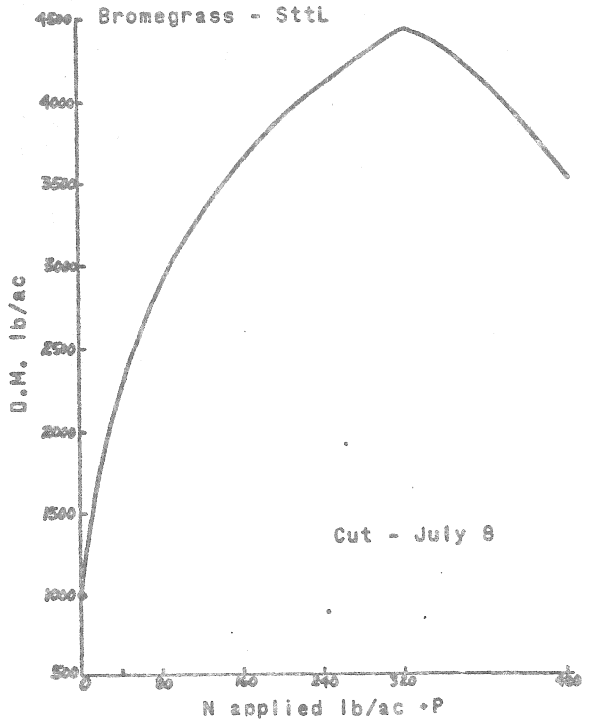


Figure 2. Effect of N rate on yield of bromegrass forage harvested at the hay stage - Scott loam, 1971.

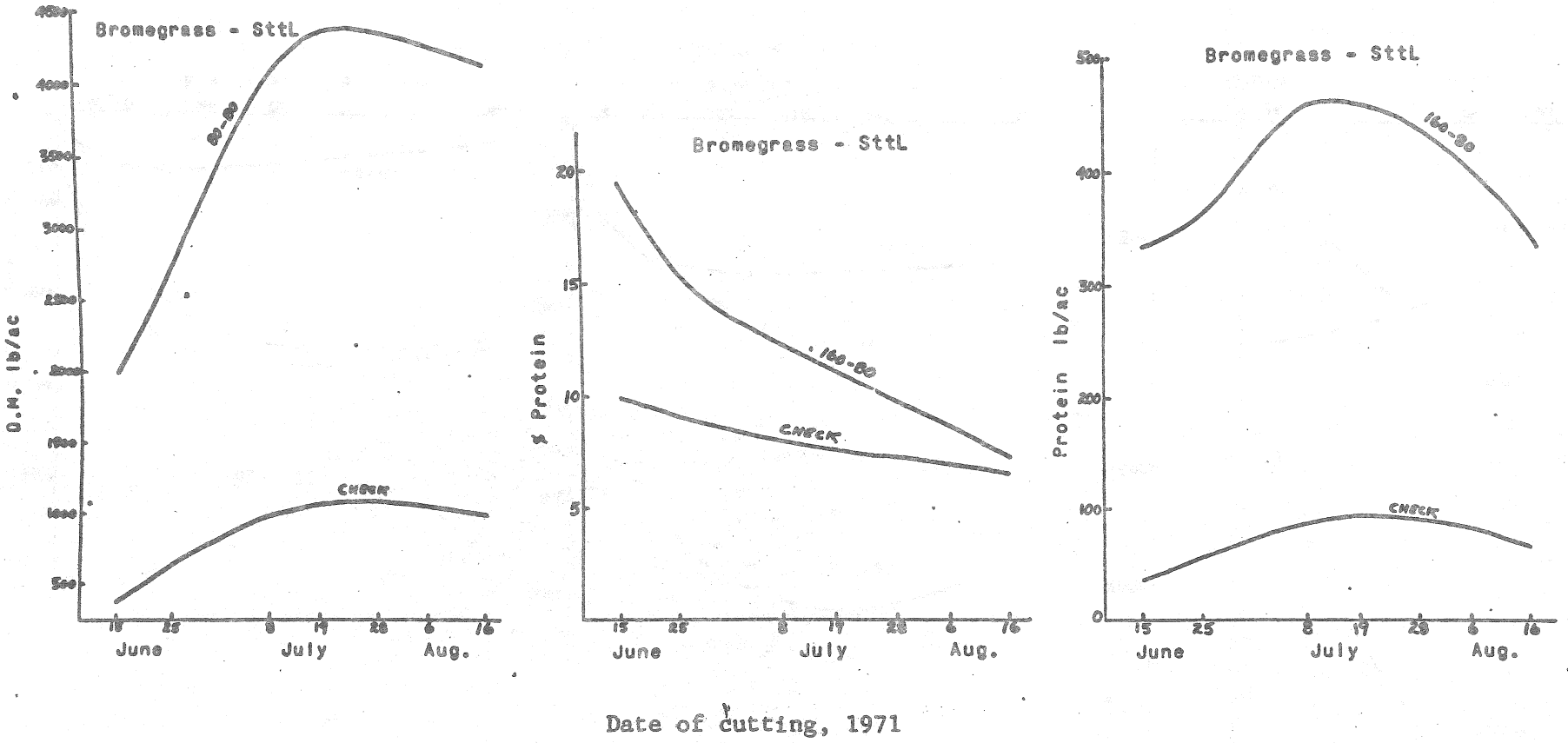


Figure 3. Dry matter (D.M.) yield, % protein and protein yield (lb/ac) of bromegrass in relation to date of cutting, 1971.

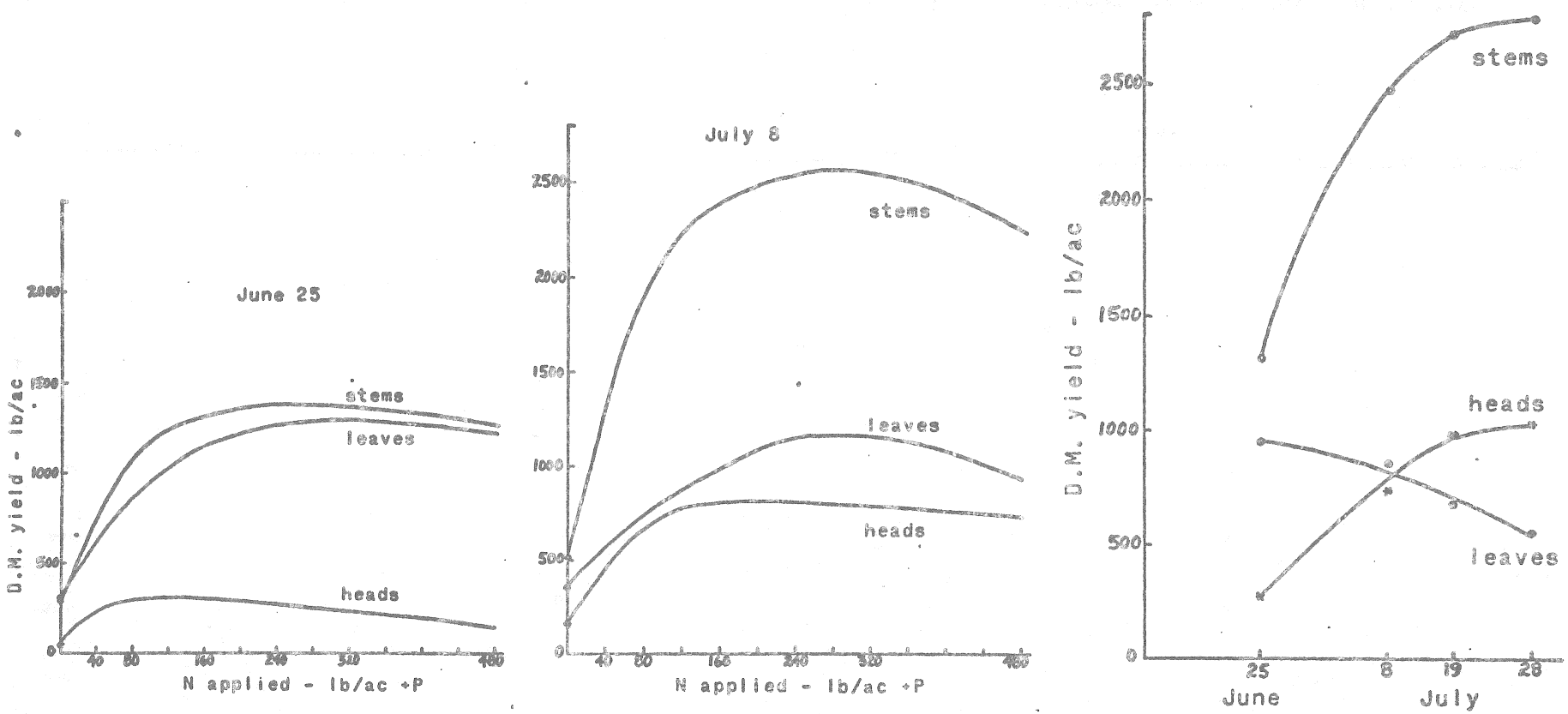


Figure 4. Contribution of stems, leaves and heads to yields of bromegrass in relation to N rate and date of cutting - Scott loam, 1971.

Table 8. Effect of N rate on protein content in bromegrass stems, leaves and heads - Scott loam, 1971.

lb/ac*		% Protein						Protein (lb/ac) July 8		
		June 25			July 8					
N	P_2O_5	Stems	Leaves	Heads	Stems	Leaves	Heads	Stems	Leaves	Heads
40	80	7.21	14.02	14.19	3.93	10.20	11.24	50	54	50
80	80	6.10	13.68	14.34	5.06	13.44	11.92	125	115	86
160	80	10.99	21.22	19.04	7.14	19.41	15.87	138	132	131
240	80	11.96	23.09	18.01	7.41	21.71	15.58	176	231	90
320	80	11.83	24.12	17.57	7.86	21.54	15.30	204	265	96
480	80	13.54	25.81	19.57	9.15	22.08	15.59	178	183	118
Check		6.52	12.80	11.96	4.23	9.32	10.49	21	33	16

* Applied in April as ammonium nitrate and treblesuperphosphate.

Table 9. Relationships between protein content and IVDOM of bromegrass forage fertilized with several rates of N - Scott loam, 1971.

lb/ac*		June 15		July 8	
N	P_2O_5	% Protein	% IVDOM	% Protein	% IVDOM
40	80	11.99	59.28	8.84	50.34
80	80	14.78	62.89	10.39	51.31
160	80	19.36	65.96	13.47	55.35
240	80	20.60	66.18	13.26	54.04
320	80	20.75	66.23	15.83	56.55
480	80	23.43	68.12	16.38	57.62
Check		9.93	57.82	9.57	54.37

* Applied in April.